Magneto-optical properties of Rydberg excitons in Cu_2O for weak and intermediate magnetic fields

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Recently, new attention has been drawn back to the subject of excitons in bulk crystals by an experimental observation of the so-called yellow exciton series in Cu_2O up to a large principal number of $n = 25$ [1]. Such excitons are named Rydberg excitons (RE). When external constant fields (electric and/or magnetic) are applied, RE, especially those with high principal number, show effects which are not observable in exciton systems with a few number of exciton states. New experimental techniques, where magnetic fields up to 150 T are available and were applied to systems with RE [2], motivate to develop theoretical description of magneto-optical properties of RE. In the case of Cu_2O, the upper limit corresponds to the so-called intermediate field regime, where the Coulomb interaction, leading to the creation of excitons, and the magnetic field, should be treated on the same footing. Our theoretical approach, based on the Real Density Matrix Approach (for example, [3]) allows one to calculate spectra for any value of the magnetic field. The results for Cu_2O and the field applied in the Faraday configuration are presented. Specifically, in the weak field regime, where the electron-hole Coulomb interaction dominates over the external field energy and the magnetic field is considered as a perturbation, we obtain an excellent fit to the experimental data by of Artyukhin et al. [3]. In the intermediate range, up to B = 150 T, the results of our theoretical calculations show a good agreement with measurements by Kobayashi et al. [2], see Fig. 1.

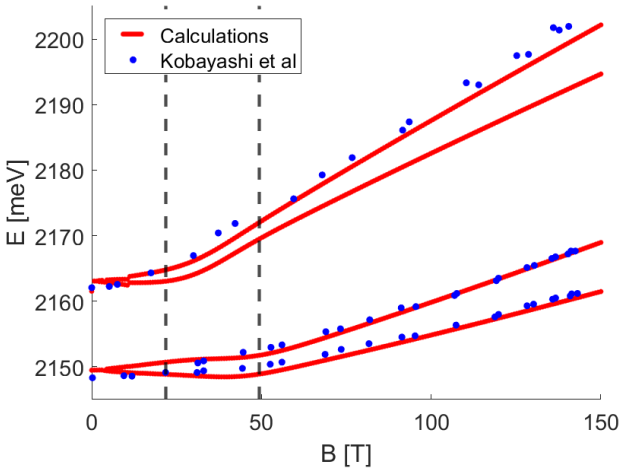

Figure 1: Calculated positions of excitonic lines compared with experimental data [2].

[1]. T. Kazimierczuk et al., *Nature* **514**, 344 (2014).
[2]. M. Kobayashi et al., *J. Phys. Soc. Jpn.* **58**, 2823 (1988).
[3]. S. Zielińska-Raczyńska et al., *Phys. Rev. B* **95**, 075204 (2017).
[4]. S. Artyukhin et al., *Scientific Reports* **8**, Article number: 7818 (2018).